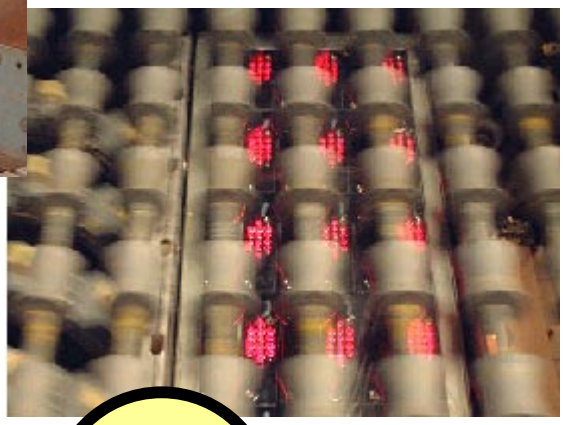

SEeMAx® Evolution

SEeMAx® version NT Evolution / MO 1.40
octobre 2002

EXTRACT

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1 PURPOSE OF THIS DOCUMENT

This is an extract of the user manual of the SEeMAx® automatic egg candling system, version «Evolution».

2 INTRODUCTION

2.1 PURPOSE OF THE INSPECTION

The purpose of the SEeMAx® system is to automatically candle eggs. SEeMAx® inspects the exterior appearance of eggshells on the packing lines, and rejects those eggs that show blemishes rendering them unsuitable for preservation or commercialization.

2.2 PRINCIPLES OF OPERATION

SEeMAx® is a high-performance artificial vision system, which automatically candles eggs.

The inspection takes place with the assistance of an artificial vision system using a matrix of CCD camera's and two LED light sources:

1. lighting from above through large diffusing panels,
2. lighting from below each egg, inspecting by transparency as on traditional candling tables.

Lights are activated in alternating sequence: first from below, then from above. Normally off, the lights flash on only during the scan.

Subsequent to the inspection, a grade is assigned to each egg.

The connection to the calibrating and packing machine is brand specific. SEeMAx® can, by way of a TOR link *(All or Nothing, 1 or 0)* , make the decision to:

⇒ keep the egg,
⇒ reject it as «Bad»,
⇒ reject it as «Very bad».

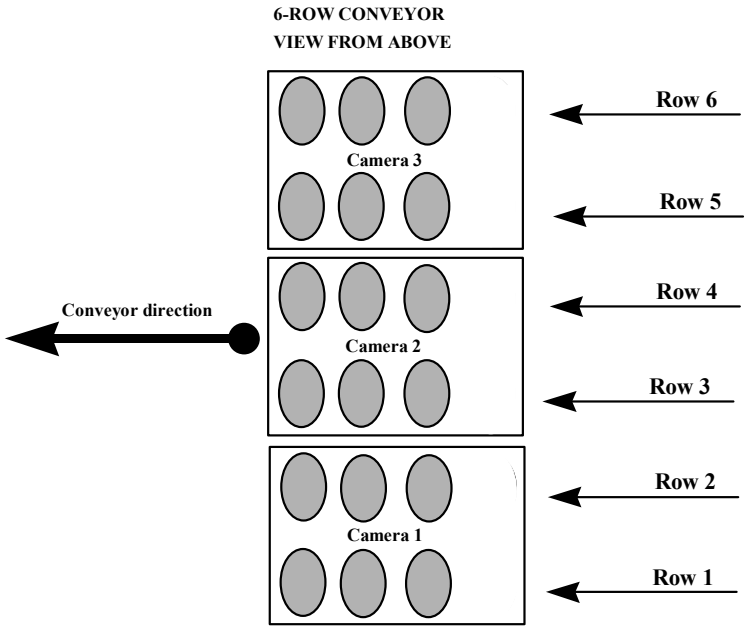
A grade is assigned by analyzing the size and shape of imperfections detected on the egg. The criteria of size and shape are adjustable parameters set by the operator.

In addition, the system verifies the color or hue of each egg. This is accomplished by comparing the value of each egg's gray-scale image against that of the current production run. These parameters are adjustable by the operator.

Each egg is checked six times: three successive steps followed by three intermediary half steps. Rotating the egg 1/6 of its circumference between scans allows practically the whole surface to be inspected.

Three cameras are used for a six-row packing line.

The fields are defined as follows:



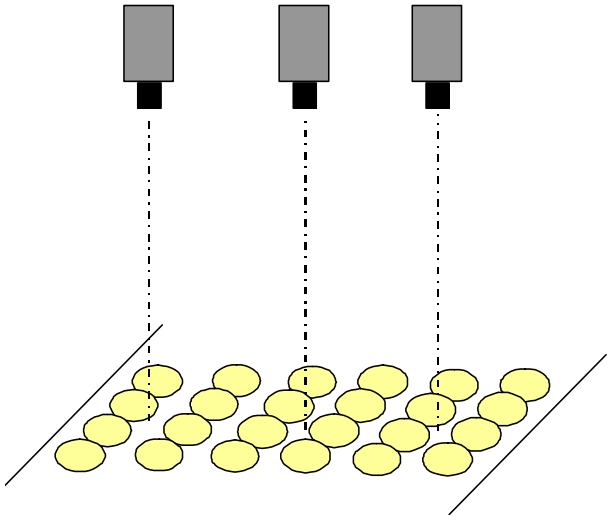
SEeMAx® acquires four images per displacement of the eggs on the conveyor belt:

- Two images at each exact « even » position, with illumination from above and below,
- Two images between each « odd » position with illumination from above and below.

One camera scans two consecutive rows on the conveyor belt, three eggs per row.

Therefore, on a conveyor belt with six rows, 4 x 3 images of 2 x 3 eggs each are taken.

Camera installation on such a conveyor belt is as follows:



The field of vision of a camera is 185mm x 210mm. The base resolution of an element of an image (pixel) is 0.3mm x 0.4mm.

2.3 INSPECTION ZONE

SEeMAx® inspects each egg six times, the egg rotating 1/6 revolution between each take, thus allowing practically the whole surface of the egg to be checked.

Yet, two zones remain veiled: the inferior and superior poles of the egg, which are not seen.

2.4 EGG REJECTION ALGORITHMS

SEeMAx® uses six rejection algorithms:

⇒ Color
⇒ Shape
⇒ Cracks
⇒ Stains
⇒ Spots and holes

Each algorithm uses specific detection criteria:

- For *color* detection, the gray-scale image of the egg is used;
- For *shape* detection, a comparative ratio between the existing shape of the egg with that of a theoretical ideal ovoid shape that would fit in the rectangle framing the egg ;
- For *crack* detection, the cumulative length of all cracks on the eggs' surface ;
- For stain detection, the cumulative surface area of all defects ;
- For *spot and hole* detection, the surface area of the largest fault on the shell.

Parameters for each algorithm are set using two reference levels:

- A lower limit,
- An upper limit.

The only parameters that cannot be set are those for shape detection.

Each algorithm produces a result either in the form of a grade from 0 to 10, or based on a level of rejection. Results are determined as follows:

- Criteria < Lower limit:

⇒ egg «accepted»,
⇒ grade = 10.

- Lower limit < Criteria < Upper limit:

⇒ Egg rejected as «bad»,
⇒ grade = 10 x (Criteria – Lower limit) / (Upper limit – Lower limit).

- Lower limit > Upper limit:

⇒ Egg rejected as «very bad»,
⇒ grade = 0.

The overall score of an egg is based on the various results obtained from each detection algorithm.

2.5 OPERATING BASICS

The basic operating cycle of SEeMAx® is as follows:

- Await the advance of the conveyor.
- Simultaneous image acquisition of the eggs by the three camera's from above, indicating forward movement by the conveyor (« SCAN »…)
- Each camera in sequence then:
- pre-processes the image,
- measures the gray-scale level of each egg,
- searches for all faults present on each egg,
- analyzes the contour of each egg.
- Compare each criterion against the reference limits. If levels are equal, rejection priority is as follows :

⇒ Color,
⇒ Shape.
⇒ Cracks,
⇒ Stains,
⇒ Spots/Holes,

- Store the results of the inspection of each egg in the lower memory buffer of a bank of registers. The register size can be selected.
- Upon receipt of the «Set result» signal, update «Results of row 1» into «Results of row n», based on the results in the upper register.
- Upon receipt of the «Reset results» signal, reset the exit «Results of row i» and shift to the top of the register.

2.6 PRODUCTION FOLLOW-UP

SEeMAx® tallies the eggs that were accepted, as well as those that were rejected as «bad» and «very bad».

SEeMAx® compiles statistics to gauge the number of rejected «Bad's» (grade from 0 to 10) and «Very bad's» (grade equal to zero) for each detection algorithm. This significantly facilitates fine-tuning of the various adjustable parameter settings associated with each algorithm.

Warning: these statistics provide but a general picture of the distribution of the types of defects. This is due to possible confusion between the types of defects (see 2.9). SEeMAx® does not sort by specific type of defect, but instead carries out a comprehensive visual inspection.

2.7 QUALITY FACTORS

SEeMAx® has several sets of adjustable parameter settings, which make it possible to choose the degree of rejection severity or «Quality Factor» implemented by SEeMAx®.

The quality levels (their names and corresponding settings) are defined by the operator.

2.8 NATURE OF THE BATCHES OF EGGS

Eggs do not always resemble each other. Large classes exist:

- «brown» or «red» eggs,
- «white» eggs,
- spotted eggs (farm-type).

These various batches require appreciably different processing parameters. SEeMAx® has several sets of pre-programmed parameters making it possible to adapt to each batch of egg.

For «white» eggs, for example, the control of egg hue (paleness) would be inhibited.

2.9 CLASSIFICATION OF DEFECTS

2.9.1 Spots and stains

Several types of spots or stains are present on eggshells:

- Blood
- Yolk
- Egg white
- Excrement: solid or liquid
- Dust deposits
- Foreign bodies stuck to the shell: straw, feathers, …
- Egg crystallization defects
- Pigmentation defects
- Calcification defects
- Localized calcium agglomerations

SEeMAx® does not see narrow stains of fresh egg white, or colorless stains of liquid excrement.

SEeMAx® does not distinguish between various stains. All visible defects on the shell are treated the same way.

The system decides to reject or accept a stained or dirty egg based on the following two criteria:

- The surface area of each defect found on the shell,
- The cumulative surface area of all defects found on the shell.

The localized defects of pigmentation, calcification and of crystallization are imperfections which can cause the rejection of an egg according to their respective surfaces areas.

2.9.2 Holes

A hole is characterized as an absence of shell.

SEeMAx® does not differentiate between holes and stains. Holes are seen by the system as stains and are dealt with using the same algorithm.

An egg containing just a small round hole (very small surface area), will not be rejected.

2.9.3 Network of micro-cracks

A network of micro-cracks is a tangle of dense, microscopic fissures, somewhat long, having the appearance of dark stains.

The network of micro-cracks is detected with the same algorithm used to find stains.

2.9.4 Cracks

A crack is a more or less marked fracture of the shell.

SEeMAx® detects the presence of open cracks, i.e. those with two disjoined edges.

The system decides to accept or reject a cracked egg based on the following criteria:

- The total cumulative length of all visible cracks on the egg.

2.9.5 Caved-in Shell

A caved-in shell is a localized depression on the eggshell.

This defect is characterized by a network of fissures in the shape of a spider web, and is often accompanied by a hole in the center of the depression.

This type of defect is detected either by the algorithm to detect stains, when a central hole exists, or by the method of detecting cracks.

2.9.6 Shape

The algorithm to check the shape of an egg verifies the contour of each egg.

The purpose of this inspection is to eliminate eggs that are completely caved-in, and those broken in two.

Severely messed-up eggs are also eliminated using this algorithm.

Detecting shape defects necessitates an excellent contrast between the egg and the rollers (i.e. impossible on yellow or gray rollers).

2.9.7 Color

Color defects derive from a lack of general pigmentation of the shell. SEeMAx® realizes color inspection by utilizing the general gray-scale image of a shell.

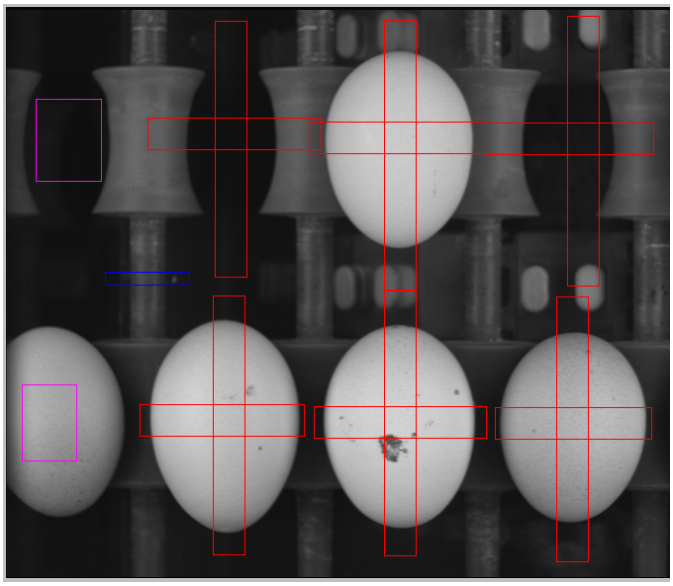
Eggs that are too clear are rejected on the basis of the following criteria:

- A Gray-scale level of the egg that exceeds (is clearer than) the percentage of the average production. The average production is based on the last 1000 eggs processed.

2.9.8 Defects not taken in account

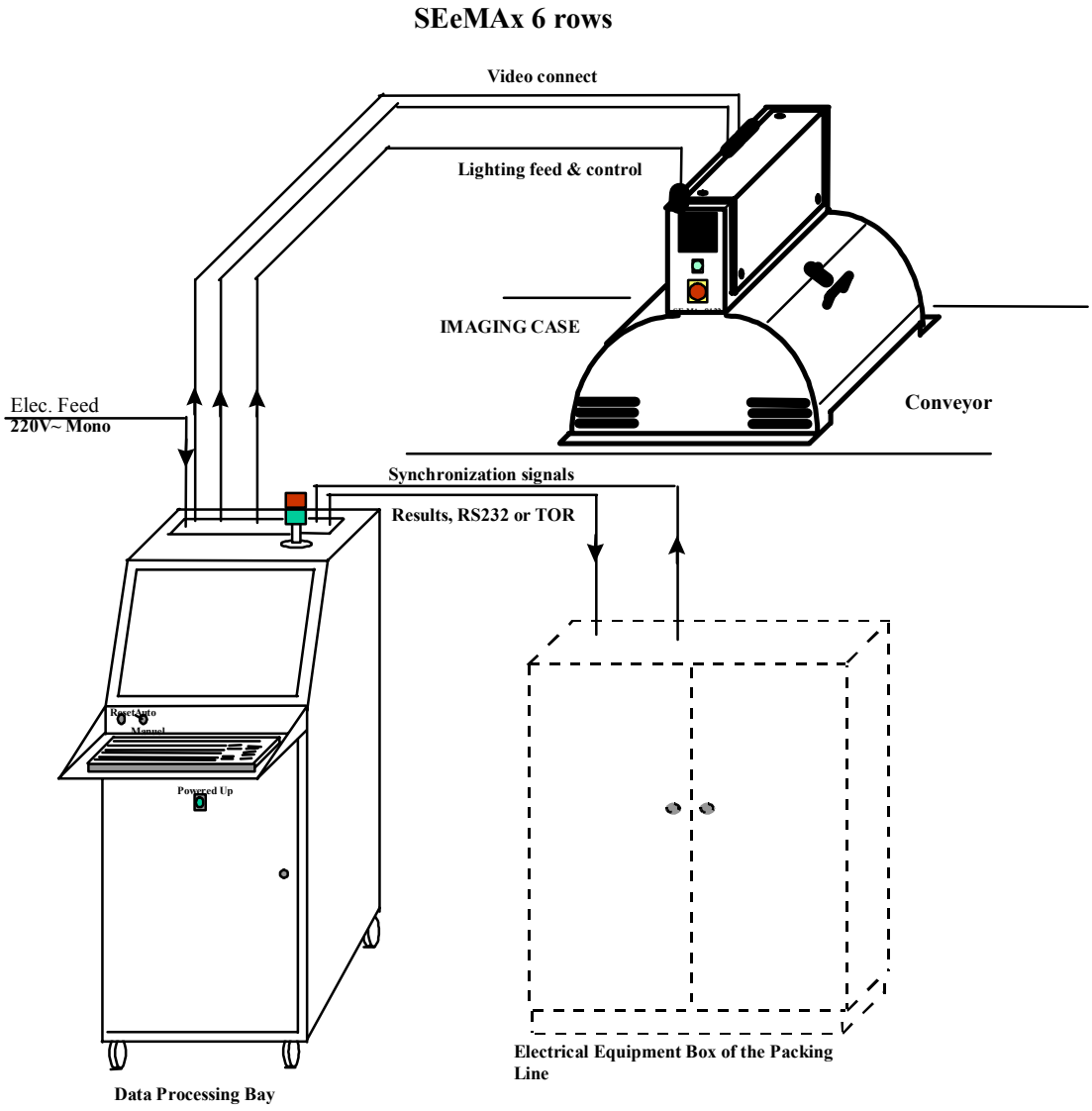
Any defect that is not a blemish is not taken into account. In particular, SEeMAx® does not check:

- Soft eggs,
- Fragile eggs,
- Micro-fissures,
- The size of the eggs' air cell,
- Blood spots inside the eggs.



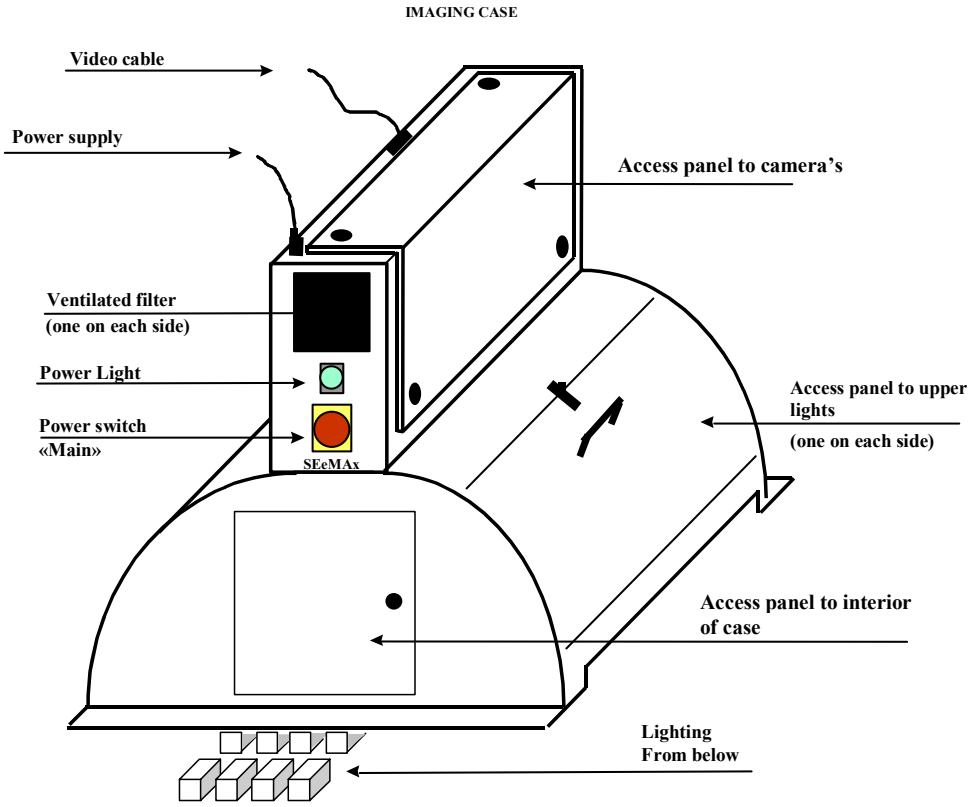
3 DESCRIPTION OF THE SYSTEM

3.1 Architecture



3.2 IMAGING CASE

The imaging case is installed directly on the packing line.



Overall dimensions for 6 rows: height: 700mm, length 715mm (dimensions likely to vary according to installation on the grading machine). Length doubled for 12 rows.

The case occupies the whole width of the conveyor.

The case is made up of two parts:

- A camera enclosure (upper part), which contains:
  - ⇒ the matrix of camera's,
  - ⇒ a camera multiplexor,
  - ⇒ an electronic platen,
  - ⇒ two ventilators.
- A lighting enclosure (lower part), which contains:
  - ⇒ two high intensity red LED panels and diffusing plates.

Positioned below the imaging case, under the conveyor:

- lights from below, composed of molded LED's arranged beneath each egg position where the inspection is carried out (step, and half step).

3.3 DATA PROCESSING BAY

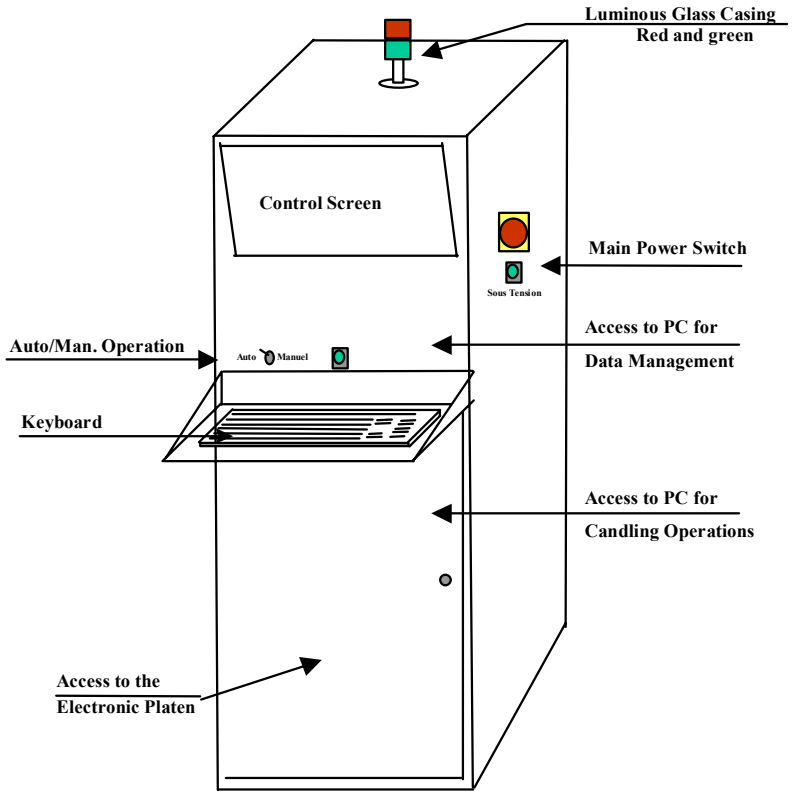
The data processing bay contains:

- A PENTIUM PC based computer, operating under Windows NT, equipped with a MATROX METEOR image acquisition card that carries out the candling functions. There is one such computer for each 6-row segment.

- One PC type computer using the Linux operating system, that provides the interface to the grading and packing machine.

- An electronic platen.

DATA PROCESSING BAY



Overall dimensions:

- Height: 2000mm (add 240mm for the Glass Casing).

- Width: 600mm. Depth: 600mm.